Investing upstream: Watershed protection in Piura, Peru

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ARTICLE INFO	ABSTRACT
	As the world is increasingly urbanized and climate change presents new uncertainties, urban water supply management needs to be flexible and adaptable. This includes reaching beyond city limits to include water supply and watershed management, as well as working with stakeholders outside the boundaries of the city, across the urban/rural divide. Bringing together diverse stakeholders to collaborate on management strategies entails bringing together multiple knowledge systems that interact, compete, and reshape water systems. Large cities located within Peru's arid coast provide important opportunities to examine these knowledge dynamics, as urban water supplies depend on actions within the rural watersheds. These watersheds, which originate high in the Andes mountains, are populated primarily by campesino communities, who have been marginalized from state-led water governance for centuries. With Peru's adoption of the 2009 Water Resources Law, campesino communities were brought into management through multi-stakeholder river basin councils. These councils ideally provide a space for stakeholders to deliberate and reach agreements on sustainable water management. Yet, despite the critical importance of upper watershed protection for ensuring water supplies for the large coastal cities, few efforts have resulted in watershed protection. Here, I examine one successful case, where the stakeholders in Piura agreed on a program to protect critical upper basin ecosystems. This study uses a process tracing approach to analyze the knowledge dynamics that led to the agreement and initial implementation. Based on ethnographic research including 112 interviews between 2015 and 2017, I argue that the interaction between knowledge and belief systems needs to be taken into account. I find that stakeholders' seemingly incongruent worldviews and epistemologies were bridged, enabling them to reach agreement on an ecosystem-based technique for watershed protection. Further, strong leadership and active support of the knowledge and preferences of the historically-marginalized campesino communities was critical for the inclusion of their views and agreement upon watershed protection. Where urban water supplies rest on actions of non-state actors, such as is the case with watershed protection, the ability of stakeholders to voluntarily reach and implement agreements is critical, especially given increased variability and uncertainties associated with climate change.

1. Introduction

Cities are at the forefront of efforts to increase climate adaptation and resilience. Defined as a city's ability to "maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity," urban resilience involves both socio-ecological interactions (Holling, 1973; Folke, 2006) and socio-technical networks (Meerow et al., 2016). Further, equity and justice are important considerations, as actions are constantly contested between diverse stakeholders with varying motivations, and climate adaptation efforts have been known to perpetuate socio-spatial inequalities (Anguelovski et al., 2016). Urban resilience mainly focuses inward on city systems; however, urban-rural connections with surrounding watersheds are critical for sustaining

water supplies (Molle, 2009). River flow, infiltration, groundwater recharge, sedimentation, and contamination depend on upstream land use. To increase resilience of urban water supplies, cities need to reach beyond urban systems and connect to watershed planning.

Collaboration and integration between sectors and across river basins have become more common with the push for Integrated Water Resources Management (IWRM). Promoted through international discussions, development assistance, and sharing of 'best practices,' IWRM shifts state-led management toward multi-stakeholder governance at the watershed scale (Molle, 2009). IWRM approaches often use river basin councils for deliberation and ideally agreement on water management between stakeholders with disparate interests (Molle, 2009). Despite numerous critiques of IWRM (Biswas, 2004; Giordano and Shah, 2014; Rahaman and Varis, 2005), integration and collaboration

persist as common water management principles (Pahl-Wostl, 2015).

Collaboration across sectors also provides key challenges. As water is critical for human and ecological well-being and used in virtually all economic sectors, stakeholders involved in and affected by water management are highly diverse, spanning government agencies, geographic contexts, and private and non-profit entities. Stakeholders may come from socio-cultural perspectives with differing norms and water practices. Participation of often-disparate stakeholders situates management between multiple knowledge systems. Knowledge systems – defined as practices by which knowledge claims get formulated, validated, circulated, and put to use in making decisions (Miller et al., 2010) – include norms, protocols, and practices from knowledge creation to use (Matsler, 2017), and are couched in stakeholders' broader belief systems. While diversity brings multiple knowledge types to collaborations for deeper understandings of issues, differences can also result in misunderstandings and disagreements over what type of knowledge is valid.

A second shift in water management introduces further challenges with respect to knowledge systems: the move toward ecosystem-based approaches. Historically, governments pursued dams, canals, and aqueducts to control water flows, but hydraulic infrastructure's ability to meet water demand has been increasingly challenged by multi-year droughts, extreme weather events, and sedimentation (Palmer et al., 2008). Ecosystem-based or 'green infrastructure' approaches are gaining traction as alternative or complimentary techniques (Schoeman et al., 2014). These interventions range from large-scale forest conservation to small bioswales that slow run-off. Conserving, restoring, and protecting ecosystems supports hydrologic services by moderating water flows, increasing infiltration, and decreasing sediment and chemical pollution. Ecosystem-based approaches, however, involve different types of knowledge than hydraulic infrastructure – namely knowledge to understand, measure, and value ecosystems (Matsler, 2017). Actors value and trust knowledge types differently. For example, policymakers may look to technical expertise, while farmers may trust tacit knowledge gained over years of experience. As such, how different knowledge systems intersect in governance needs attention.

Collaborative governance literature provides a starting point for understanding stakeholder interactions within river basin councils. Scholars have analyzed how and why stakeholders deliberate and collaborate (Acheampong et al., 2016), yet few incorporate a deep analysis of the role knowledge and belief systems play (Ansell and Gash, 2008). Diverse knowledge is seen as an asset to better understand issues (Emerson et al., 2012), but differences can also lead to misunderstandings, marginalization of actors that lack certain knowledge (Muñoz-Erickson, 2014), or co-option of decision-making.

This paper examines knowledge dynamics of water management that resulted in a watershed protection agreement in Piura, Peru. Within Peru's integrated, collaborative water management system, ecosystem protection efforts have increased but hydraulic approaches still dominate. Despite similar efforts elsewhere, Piura is one of the few regions to reach agreement on watershed protection. River basin council members agreed to establish the Regional Fund for Water and Sanitation (FORASAN) and subsequently began implementation. Piura provides a good case to examine knowledge dynamics due to high stakeholder diversity across differing socio-ecological contexts, from large downstream cities to rural Andean mountains. As such, I ask: in Piura, how did knowledge and belief systems affect stakeholders' agreement upon watershed protection?

This paper begins with an examination of how urban and rural systems interface through collaborative water governance regimes. Then, I introduce the case through which I examine knowledge dynamics – watershed protection in Piura – and outline methods. The third section details how the case unfolded, which the subsequent section analyzes. Finally, I conclude with broader insights.

2. Urban/rural interface: collaborative water governance regimes

Since water links cities to their peri-urban/rural surroundings, water management provides key spaces to negotiate their relation. Political ecology scholars have exposed how urbanization can exacerbate unequal power relations, whereby cities dominate water control while marginalizing those on the outskirts (Swyngedouw, 1995; Heynen et al., 2006). While insightful, they rarely address the interactions between stakeholders, which is critical when decisions are made through deliberative processes. Collaborative water management brings together stakeholders across differing geographic areas to integrate municipal, agriculture, hydropower, industry, and other uses, thus providing nodes where different knowledge types meet.

Multiple literatures have shed light on stakeholder interaction in natural resource management. Adaptive governance focuses on institutional arrangements for managing complex, dynamic systems under high uncertainty, using experimentation and learning (Folke et al., 2005; Olsson et al., 2006; Dietz et al., 2003). However, it relies heavily on scientific information and rarely considers how power relations shape decisions or how decisions affect socio-political dynamics (Wyborn, 2015).

In contrast, collaborative and deliberative governance focus on socio-political processes of decision making (Leach, 2007). These approaches are particularly insightful when government and non-government stakeholders engage in deliberative, consensus-oriented decision-making (Ansell and Gash, 2008), such as river basin councils. While terminology varies, the collaborative governance literature broadly stems from Habermas' notion of communicative rationality, whereby stakeholders engage in deliberative 'truth-seeking' processes of dialogue, argumentation, and persuasion to reach the 'best' solution (Risse, 2000). By sharing multiple perspectives and knowledge, actors should better understand the issue and potential solutions (Beierle, 2002; Fischer, 2000; Reed, 2008; Wondolleck and Yaffee, 2000). Further, collaboration should help boost democratic legitimacy by engaging stakeholders in decision-making (Pelletier et al., 1999; Fischer, 2000; Elster, 1998), strengthen compliance as actors view the result as more legitimate (Richards et al., 2004), and build stronger relationships (Frame et al., 2004; Tett et al., 2003; Warner, 2007). Recognizing different conceptualizations of governance, this article draws primarily on collaborative governance given that it best reflects the Peruvian approach whereby stakeholders are expected to deliberate and reach consensus. Yet, as explored below, even when democratizing in certain ways, collaborative governance can result in control and marginalization (Swyngedouw, 2005).

Scholars have identified numerous factors that affect whether collaboration results in theorized outcomes. Conceptually, collaborative governance regimes are situated within system contexts and composed of institutional design characteristics and deliberative processes (Emerson et al., 2012). The system context includes the surrounding socio-political and economic relations, institutional context, and ecological/technical systems (Bryson, Crosby, and Stone 2006; Ostrom, 1990; Pahl-Wostl, 2015; Plummer and Fitzgibbon, 2004; Wondolleck and Yaffee, 2000). Most scholars, however, focus on the regime itself. The institutional design establishes how it operates, including participation, goal/purpose, rules/procedures, and leadership/facilitation (Bryson, Crosby, and Stone 2006; Day and Gunton, 2003; Glasbergen and Driessen, 2005; Huxham et al., 2000; Imperial, 2005; Innes and Booher, 2004; Schusler et al., 2003; Vangen and Huxham, 2003b). Leadership, in particular, can help facilitate collaboration and trust-building, ensure broad and equal participation, and craft consensus solutions (Vangen and Huxham, 2003a; Lasker and Weiss, 2003; Susskind and Cruikshank, 1987). Within the regime, deliberation, developing shared understandings, and trust-building affect the extent to which stakeholders reach desired outcomes (Ansell and Gash, 2008; Emerson and Nabatchi, 2015; Wondolleck and Yaffee, 2000).

Collaborative governance scholars have provided extensive insight

into why and how stakeholders deliberate, but few give sufficient attention to knowledge systems and power relations. Deliberative processes may touch on knowledge dynamics (for instance, contributing to shared understandings), but they rarely examine sufficiently to determine its impacts. Power relations shape whose interpretations and knowledge are taken over others (Wyborn, 2015). For example, McCullum et al. (2003) found stakeholders developed a shared understanding in a participatory food security collaboration, but it mirrored that of the most powerful actor. This begs the question of whether stakeholders reached a shared understanding due to co-option, rather than genuine deliberation. Dominant actors' knowledge and perspectives could dictate due to unequal power relations and lend legitimacy under the veneer of collaboration. Such situations could be counterproductive in terms of trust-building and could further strengthen the discourses of the powerful.

Knowledge systems scholars have identified disconnects between science and policy. Cash et al. (2003, 2006) highlight that for science to be 'usable', it must be credible, salient, and legitimate. Chilvers (2008) brought this work into dialogue with collaborative governance by expanding actor types, expertise, and knowledge. Yet, as Muñoz-Erickson (2014) highlights, the knowledge systems literature has narrowly focused on knowledge processes with a shallow understanding of how knowledge and social orders co-produce each other. Co-production involves dynamic political processes of knowledge creation, contestation, and stabilization (Jasanoff, 2004), which is critical for regimes relying on voluntary implementation and societal acceptance.

Co-production reveals that knowledge is situated within broader belief systems that are comprised of actor worldviews and epistemologies (Miller, 2008). People interpret the world through different mental models (Hajer and Wagenaar, 2003), and these worldviews shape beliefs about what constitutes a 'problem', cause-effect relations, and equity and trade-offs (Clapp and Dauvergne, 2011; Dunlap and Van Liere, 1978; Jones et al., 2011). Worldviews in turn shape epistemologies – philosophical views of the types of knowledge that can inform our understanding of the world – which guide which techniques we believe will address specific issues. If decisions do not rest on a type of knowledge stakeholders trust, it may compromise legitimacy in their eyes. Legitimacy is not only key for reaching agreement, but also stakeholders' willingness to implement decisions. Wyborn (2015) shows this empirically, demonstrating how context, knowledge, and governance intersect in "co-productive interplay" (64). Disparities in whose perspectives are taken into account are too often overlooked in collaborative governance, as emphasis is placed on shared understandings.

Compared to purely urban systems, collaborative water governance regimes introduce greater knowledge variation. While each regime is unique, they typically span urban/rural boundaries and have greater geographic, ecosystem, and climatic variation. Regimes frequently cross socio-political and cultural boundaries and include dissimilar management structures. For example, cities may use water utilities while rural areas have community water boards. Further, individuals' belief systems and relationships to water shape their interactions within collaborative regimes. Thus, knowledge diversity is common in collaborations spanning urban-rural contexts, and knowledge interaction is critical for ensuring sustainable water supplies.

A complementary body of literature focuses on payment for ecosystem services (PES) programs that compensate land managers for the ecosystem services of their resources. Despite extensive examination of institutional mechanisms, social and environmental outcomes, and challenges (Redford and Adams, 2009; Jack et al., 2008), PES scholarship rarely discusses how and whose knowledge shapes programs (Costanza et al., 2017; Paudyl et al., 2016). Further, few consider unequal power dynamics or risks to service providers, such as loss of autonomy (Fletcher and Büscher, 2017; Redford and Adams, 2009; Rodríguez de Francisco et al., 2016; Rodríguez de Francisco, et al. 2013). Recent literature has highlighted the need to involve stakeholders in establishment of programs and incorporate indigenous

knowledge (Reed et al., 2017; Paudyl et al., 2016). Therefore, this article seeks to understand knowledge dynamics of deliberative processes establishing a watershed protection program.

3. Methods

This study examines when and how knowledge and belief systems affect collaborative governance, focusing on the process and nature of agreement. While environmental and socio-political outcomes are also important, it was too soon to fully assess those in the case analyzed. I did, however, undertake an analysis of the first steps of implementation to ensure the agreement was not solely on paper. I used case study analysis to enable inclusion of complex, dynamic factors and identification of causal mechanisms, as the characteristics of social interactions influences the texture of the result, not just whether a result occurs (George and Bennett, 2005).

This paper presents one of four collaborative water management cases in a broader project, this one focused on watershed protection in Piura. These provide empirical analyses from Latin America, filling a much-needed gap of studies outside Europe and the United States. Piura has one of the first six river basin councils established under Peru's 2009 Water Resources Law. It spans the Chira and Piura Rivers, is multi-sectoral and participatory, and includes both rural and urban stakeholders. As is common in Peru, most of the basin's cities and water use occur in the arid coastal zone and receive water from the Andes mountains.

Data sources include interviews, participant observation, and document data. I interviewed stakeholders from different sectors, levels of governance, and parts of the basin between 2015 and 2017. I identified interviewees first through snowball sampling and then through stakeholder analysis aimed at basin council stakeholders and water experts. Of the 245 interviews completed in this research project, 112 were related to the case analyzed here, including interviews at both national (65) and basin (47) levels. Three were with campesino community leaders and 14 with people who worked closely with them, so existing anthropological and other studies were used to complement interviews within the analysis (such as Boelens et al., 2014; Mills-Novoa et al., 2017; Seligmann and Fine-Dare, 2019). The semi-structured interviews focused on three aspects of water management: knowledge about management, stakeholder participation and interactions, and how knowledge was used and shaped outcomes. In addition to interviews, data included participant observation of events and meetings, such as an August 2015 El Niño forum with over 100 participants, and review of basin council documents (basin diagnostic, water resources basin management plan, media, and workshop and meeting results).

I used process tracing and counterfactual analysis to determine how the variables interacted and impacted outcomes. Process tracing uses causal process observations to analyze how and why events occurred (Beach and Pedersen, 2013; Bennett and Checkel, 2012). It seeks to uncover explanations for past events by identifying intervening variables and causal mechanisms, while ruling out plausible alternative explanations. In this study, I used a two-step process, first analyzing stakeholder knowledge and belief systems, and then tracing how knowledge dynamics affected collaborative outcomes.

Knowledge and belief systems were assessed through looking at congruence of worldviews and epistemologies. I evaluated worldviews and epistemologies in terms of their 'congruence,' meaning the extent to which they allowed stakeholders to support similar techniques to address problems. Worldviews and epistemologies were identified through a adaptive theory approach, going back and forth between existing scholarship and themes that emerged through interviews (Layder, 1998). Since belief systems are both shaped by individual experiences and shared among social groups, I used triangulation between interviews and secondary sources to identify those most characteristic of primary stakeholder groups.

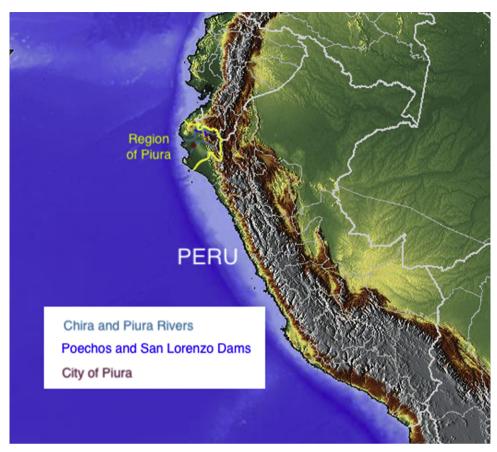In the second step of the analysis, I used process tracing to unpack

Fig. 1. Map of the Chira-Piura Basin.

how knowledge and belief systems mattered through examining the basin council's deliberative dynamics. In examining the process, I noted already-theorized processes from the literature (deliberation, developing shared understandings, trust-building, etc.; Emerson and Nabatchi, 2015; Ansell and Gash, 2008; Wondolleck and Yaffee, 2000), but focused on knowledge dynamics. The analysis included knowledge production, validation, contestation, and use, attune to how different knowledge types intersected, the extent to which one dominated, and reconciliation.

4. Watershed protection through Piura's regional fund for water

Before presenting the analysis, we first examine the process through which Piura decided to establish FORASAN. The Chira and Piura Rivers make up 87 percent of the political region of Piura, flowing from the Andes mountains down to the Pacific coast (Fig. 1). Although most water demand comes from the arid lower basins, most precipitation falls in the Andean upper basin. To enable urban and agricultural expansion, the government built the Poechos and San Lorenzo dams in the Chira basin, as well as aqueducts to transport water from the Poechos dam to the regional capital, Piura, and agricultural areas in the lower Piura basin. Thus, both lower basins receive water from the upper Chira watershed ('lower basins' refers to below the dams).

Historically, the government primarily managed water for irrigation below the dams, with little involvement of peasants in the upper Chira basin, most of whom were part of campesino communities.[1] Although

Piura began including some non-state actors in water management in the mid-2000s, it limited participation to agriculture. As one interviewee put it:

> The issue of water resources, traditionally, has been the concern of farmers. The water was agricultural, so the priority of those who managed water was limited to irrigation. There was no multi-sectoral appreciation of the issue, only that water was used when it reached the coast and used for irrigation because the main economic activity of the region is agriculture on the coast. There is agriculture in the mountains, but it is not economically fundamental.[2]

The government supported urban development, hydropower, and other non-agricultural uses through hydraulic systems, but they were not formally included in management. The government operator of hydraulic infrastructure accounted for them, centering water management decisions in the city of Piura. Andean communities were also excluded from water decision-making.

The upper-lower basin relationship became evident with the 1997-98 El Niño. During preceding decades, wood collection, agricultural expansion, overgrazing, and fires had deforested over 500,000 ha in Piura, with a majority in the upper basin (Kometter, 2012). Extensive El Niño rains washed loose sediment downstream into the Poechos dam, reducing its capacity by 54 percent. This impinged on domestic water use, as farmers drew water from canals before it reached the main

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(footnote continued)

marginalization, or disputes over land tenure, but did provide some standing to maintain traditional practices, even if somewhat ambiguous (Vera-Delgado, 2011). Campesino communities are distinct from 'indigenous communities' in the Amazon.

[2] Interview with Special Project of Irrigation and Hydroelectricity of the Alto Piura (PEIHAP) given and translated from Spanish by author, July 20, 2016.

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[1] 'Campesino communities' have legal standing in Peru (Law Nº 24656), They gained that name during the 1969 Agrarian Reform, when the government sought to equalize rural farmers, which were a mix of indigenous (pre-Spanish), mestizos (mixed indigenous and Spanish), and other variations thereof. In practice, applying the same name did not change cultural divides,

cities. For example, the 2016 drought hit the city hard:

> In December, we no longer had water in the reservoirs for human consumption. We were at such a critical point when farmers broke the floodgates and put pumps to irrigate their crops from the canals that supply water for the population.[3]

Following the 2009 Water Resources Law, in 2011 the Regional Government of Piura established the Chira-Piura Water Resources River Basin Council for stakeholder deliberation and agreement on water management. The Law outlined the Council's 10 representatives: National Water Authority (ANA), regional government, local governments, major water infrastructure operators, agricultural users, non-agricultural users, universities, professional associations, campesino communities, and Ministry of Foreign Affairs. The Regional Natural Resources Manager (GRRN), the regional government lead for the environment, was President.

The Council developed the Water Resources Basin Management Plan, which included watershed protection, among many actions. However, the Council had no direct control over water or land use. Rather, representatives could agree to undertake voluntary actions or make recommendations to ANA or other entities.

Two maps highlighted the Council's view of the upper basins. The 'basin we have' map noted deforestation and erosion causing sedimentation, landslides, informal mining, and poverty, as well as the páramos and cloud forests as areas of potential. Then, the 'basin we want' map included soil conservation, dams, forest conservation/reforestation, wetland recuperation, and greater rural access to potable water (ANA, 2013). While showing concern for the upper basins, these maps included both hydraulic and ecosystem-based techniques.

Watershed protection was promoted both directly and indirectly. The Technical Secretariat facilitated a Working Group on Climate Change and Risk Management with technicians and stakeholders. Despite broad participation, most were from the lower basin. With international development assistance, they used models to evaluate scenarios, such as the Water Evaluation and Planning (WEAP) System. As one stakeholder described:

> …when we have worked with [models]… each stakeholder comes with their own interests, but it is the models, the processes of construction of the models, that are very participatory. There is the opportunity to incorporate ideas.[4]

The models showed the hydrologic benefit of watershed protection. A model of the Chira sub-basins Quiroz and Chipillico showed that while 19,800 ha of páramos normally supported 2.31–2.65 m^3/s dry season flow, a 30 percent loss of páramos would decrease flow by 14.5 percent from 2010 to 2059 (Portocarrero, 2015a). They also undertook complimentary studies – of actors, legal viability, economic/financial feasibility, among others (Portocarrero, 2015b). Despite little site-specific data that could project hydrologic benefits of Andean interventions, numerous studies showed the hydrologic importance of cloud forest and páramos ecosystems (Farley and Bremer, 2017; Quintero, Wunder, and Estrada 2009).

The President and Technical Secretariat also led activities to raise awareness of upper basin ecosystems and strengthen stakeholders' understandings of each other. They held workshops and exchanges, bringing downstream stakeholders to visit Andean páramos and talk with campesinos, and brought campesinos to cities (Portocarrero, 2015a). Through these, downstream water users saw offerings campesinos left to the gods, such as *Mama Quocha* (Mother Water) and local mountain deities, for the water. The link between poverty, lack of

economic opportunity, and overgrazing was also evident. As a result of exchanges:

> Now, with FORASAN, [there is more understanding by those that live upstream about life in the lower basin, and of those that live downstream about life in the mountains]. We have taken people… up to the highlands to know where the Cuyas forest is, where the water comes from.[5]

Increased understanding about upper basin ecosystems was widely noted among Council participants, although they noted most people outside the Council only thought of water below dams. As one interviewee put it: "[Ecosystems' role in production of water resources] is not a very widespread issue. Ecosystem management is new terminology, not used much."[6] Stakeholders varied in their understanding of the watershed, from being only focused on precipitation and surface flows to acknowledging ecosystems and non-visible water circulation. As one noted: "More people are concerned about…the upper basin for water – but just that it comes from the upper basin, not ecosystems per se…"[7] Nonetheless, Council participants recognized its importance.

Meanwhile, the President and Technical Secretariat, with international development assistance, designed a watershed protection mechanism that would become FORASAN. They designed a fund to which private entities could contribute and found a well-respected Peruvian non-profit organization for management and implementation. It was designed as an umbrella under which both watershed protection and water conservation actions could fall, including both financial contributions and direct implementation.

As the Basin Council discussed approval of FORASAN, most representatives looked to the technical Working Group for guidance. One stakeholder described this transition from the Working Group to the Council:

> … the initial work was with Working Groups because they are the most prepared people in terms of understanding [the issue]. They are the people in institutions that use tools, apply them, everything. But you have to take advantage of the validation spaces. I worked on a model with [Working Groups], but this process then had to cross from the technical to political side and enter the Basin Council in the validation or officialization stage, which gives value to that process.[8]

She went on to describe how representatives respected the Working Group's modeling efforts because they derived results in a participatory manner, not by only one stakeholder.

The President and Technical Secretariat were hopeful downstream water users would financially contribute to FORASAN since ultimately, they relied on the ecosystem services. Not everyone shared this view though:

> Cooperation programs are pushing the lower parts [of the basins] to finance the upper parts, but this concept is difficult here because we feel it is a concept of the State. It's the government that needs to redistribute resources. There is not a direct contribution [from the lower to upper parts].[9]

In other words, since the government had historically financed hydraulic infrastructure, some stakeholders thought it was not their responsibility to maintain water supplies.

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[3] Interview with Regional Natural Resources Manager (GRRN) given and translated from Spanish by author, March 8, 2017.

[4] Interview with PARA-Agua given and translated from Spanish by author, April 7, 2016.

[5] Interview with GRRN given and translated from Spanish by author, July 13, 2016.

[6] Interview with PEIHAP given and translated from Spanish by author, July 20, 2016.

[7] *Ibid.*

[8] Interview with PARA-Agua given and translated from Spanish by author, April 7, 2016.

[9] Interview with PEIHAP given and translated from Spanish by author, July 20, 2016.

While the campesino community representative was the only up-stream stakeholder on the Council, initial FORASAN projects were ones campesinos wanted – private protected areas around important eco-systems, which they needed the government's help to establish. Campesino communities occupied over 50 percent of Piura but often lacked legal titles, and the establishment of protected areas helped prevent the government from issuing mining concessions on that land. Further, FORASAN would provide funds campesinos needed to imple-ment reforestation, sustainable land use management, and possibly new economic opportunities like tourism. Council members did not disagree with such actions, and given the flexible design, they could agree to FORASAN without committing their constituencies to actions or funds. In 2015, the Council agreed to the establishment of FORASAN.

Agreement on the Basin Management Plan and FORASAN did not guarantee their implementation. As the Council President lamented, in the years that followed it became apparent that the Plan did not in-fluence stakeholder decisions in terms of which projects to pursue, for watershed protection or other aspects of water management.[10] For example, even though Piura's water utility had a new mandate to invest in watershed protection, they were unsure if they would support FORASAN or implement their own projects.

Shortly after establishing FORASAN, stakeholders began under-taking actions to implement it. The first actions included the estab-lishment of private protected areas, building on the experience from small-scale disaster resilience projects the GRRN and international de-velopment had done in the 2000s. They used zoning to identify initial areas for conservation, from which they gauged community interest. FORASAN prioritized the 22 percent of the region zoned for protection and conservation and the 14 percent marked for recuperation. Within FORASAN's first years, the GGRN and campesino communities estab-lished two private protected areas – Cuyas and Samanga – where they began conservation projects, such as planting 10,000 native trees in Samanga (AIDER, 2018). While international development agencies supported initial phases of implementation, local entities also con-tributed financially, including two agricultural water user boards and one private company.

5. Analysis

5.1. Congruence between worldviews and epistemologies

Before analyzing knowledge dynamics, I inductively categorized stakeholders' worldviews and epistemologies within which knowledge systems are couched. In Piura, actors had three main worldviews – Andean cosmological, hydrologic, and anthropocentric. While each has distinct characteristics, individuals could hold multiple worldviews in cognitive dissonance.

Campesinos' Andean cosmological worldview sees the earth as sacred and believes it is important to keep humans and nature in bal-ance. Nature forms a key element of identity and spirituality, such as local mountains that had situated and relational value. While specific beliefs varied between Andean communities, many believed deities provided water for them and left offerings. The Andean cosmology was also linked to traditional social practices. For centuries, communal water distribution decisions formed the basis for societal organization in Andean communities, resting heavily on reciprocity – a balance that if lost could upset the gods (Boelens and Seemann, 2014). While the communities in Piura had more individual ownership than other parts of the country, they still communally managed wetlands.

In contrast, stakeholders with hydrologic worldviews aligned with western science in viewing the natural circulation of water as in-dependent from humans (Maidment, 1993). Water flows are cyclical – evaporating, circulating, and condensing. Ecosystems feature

prominently, as they are critical for absorbing, storing, and infiltrating water. Yet, as Linton and Budds (2014) highlighted, the hydrologic cycle is a social construct itself: "By constituting a new field of scientific enquiry [on the hydrologic cycle] and an associated group of knowl-edge workers, the hydrologic cycle also helped legitimize a certain technical authority over water" (171). The hydrologic worldview im-plicitly disregards the socio-cultural, political, and historical dimen-sions through which water is understood. While not ignoring built in-frastructure, it emphasizes weather, climate, and ecosystems as primary determinants of scarcity.

Although literature on local indigenous knowledge typically con-trasts it from western scientific knowledge (Berkes, 2012), in Piura a third 'anthropocentric' worldview was also present. These stakeholders focused on observable water flows, their human utility, and control through human-built infrastructure. They acknowledged water as a resource central to society, the economy, and politics, but questioned unobservable water flows (e.g. infiltration, evaporation, absorption). Their social construct was water as a resource based on availability, not a cyclic flow of matter. As a result, actors with anthropocentric worldviews questioned the role of ecosystems in water supplies and climate resilience and favored management techniques that had visible effect on water flows, such as dams.

In Piura, stakeholder worldviews were split along geographic lines. In the upper Chira basin, campesino communities primarily held Andean cosmological worldviews. While it is plausible statements were framed with the goal of receiving funding, this was verified through secondary literature on Andean cosmology and campesino practices. Downstream, however, stakeholders had hydrologic and/or anthropo-centric worldviews, many exhibiting characteristics of both. This was evident in their reflections about the upper basin – interviewees that had been involved with the Basin Council noted the upper basin's im-portance for water supplies, but some were less certain about ecosys-tems. Interviewees noted the recent shift from anthropocentric towards hydrologic worldviews, but cautioned this was not widely shared out-side the Council; most of the region thought only in terms of hydraulic infrastructure. When questioned about why, they pointed to ANA's workshops, media about climate change, and international develop-ment.

The difference in worldviews affected beliefs about what techniques 'work', given differing philosophical views about cause-effect. This was evident when discussing water supply sustainability – actors with an-thropocentric worldviews believed more dams were needed, whereas those with hydrologic worldviews also looked toward ecosystem re-storation. The Andean cosmological worldview was distinct still – ecosystems were valued as part of the human-nature balance, but de-gradation was a combination of their relationship with the gods and poverty that caused individuals to put pressure on ecosystems and disrupt community management. Of note, campesinos did not oppose hydraulic infrastructure. Yet, while hydraulic infrastructure had been historically favored in the basin, the Basin Council agreed to an eco-system-based approach (even as the regional government still pursued hydraulic infrastructure).

In terms of epistemologies, a slightly different configuration emerged. Stakeholders held four different epistemologies, defined based on the types of knowledge trusted and viewed as valid:

- **Techno-scientific** – derived from technical and/or scientific ana-lyses.
- **Practice-based** – gained through practice and experience, such as farming under differing conditions.[11]

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[10] Interview with GRRN by author, July 13, 2016.

[11] Practice-based and observational knowledge are together similar to what scholars have termed tacit or experiential knowledge (Pahl-Wostl et al., 2007), but are broken down here to explicitly acknowledge their differing origins, as they were evident here.

- **Observational** – from observation, such as of weather events, ecosystem changes, and water flows changes.
- **Traditional** – passed down between generations, shown to be tried and true.

In Piura, a majority of downstream actors (farmers, hydropower, water utility, infrastructure operators, ANA, regional government, local governments, universities, professional associations) had techno-scientific epistemologies, looking to techno-scientific information to understand new phenomena and make decisions. Water users also noted the importance of practice-based knowledge. Importantly, farmers varied based on farm size, with larger farmers relying more on techno-scientific knowledge and smaller ones practice-based knowledge. Campesinos, who engaged primarily in subsistence agriculture or herding, had practice-based, observational, and traditional epistemologies. None interviewed exhibited trust of techno-scientific information, perhaps because that had historically been used to justify encroachment on their lands.

Importantly, epistemologies do not necessarily imply knowledge, although stakeholders often value the knowledge type they have. Here, campesinos had practice-based, observational, and traditional knowledge. Downstream actors had varying levels of practice-based and techno-scientific knowledge, often sector-specific. Although many actors had practice-based knowledge, only campesinos' was about ecosystem management specifically. Techno-scientific knowledge was valued by actors that did not have it, namely small farmers.

Technique preferences revealed that worldviews and epistemologies were incongruent prior to the Basin Council. Downstream stakeholders initially viewed hydraulic infrastructure as appropriate for water management. The Council President, Technical Secretariat, and some non-governmental organizations were among the few that supported ecosystem-based approaches. Campesinos also voiced support for ecosystem-based techniques.

5.2. Tracing the deliberative dynamics

Knowledge dynamics help explain how the Basin Council agreed to an ecosystem-based approach. Tracing the process, three sets of factors emerge that help explain agreement – increased general understanding, bridged knowledge and belief systems, and crafting of an implementable program. Across all, leadership was key. Further, knowledge dynamics reveal that even though downstream actors dominated the Council, FORASAN aligned with upstream campesinos' preferences. This was surprising because, as highlighted by Anguelovski et al. (2016), planning efforts frequently align with elite groups over vulnerable ones.

Downstream actors' new understanding of the upper basin's importance for water supplies paved the way for an ecosystem-based approach. ANA workshops provided information from a source stakeholders trusted. Then, participatory modeling produced basin-specific techno-scientific information that was viewed as unbiased. While some stakeholders were not fully convinced about ecosystems' overall importance, focusing on the páramos helped generate agreement since numerous studies highlighted their hydrologic significance. Even though an anthropocentric worldview used to dominate, Council members increasingly held a hydrologic one:

> We used to talk about water only from below the reservoirs. Now there is an understanding of what is a watershed and the hydrological cycle of water, which means that water is no longer born from reservoirs as previously thought.[12]

Additionally, a deeper understanding of other stakeholders'

perspectives increased openness to working together. Interviewees cited site visits as strengthening their understanding of how geographic and climatic differences produced different conditions and struggles. As an ex-Basin Council President highlighted, listening to challenges others faced and seeing their context deepened respect for their challenges, such as lack of institutional structure and economic opportunities in the upper Chira basin, which fostered empathy and willingness to collaborate.

Second, building on the increased understanding of Andean ecosystems and stakeholders' perspectives, Council discussions and activities bridged differing belief systems. Material interests mattered as well, but they changed little from prior to the Council, showing that agreement was not purely explained by interests themselves, but rather dialogue and knowledge dynamics contributed to new understandings of interests. Bridging refers to the process of relating differing belief systems such that they converged on a shared understanding of appropriate techniques. Here, the downstream stakeholders (namely the farmers, water utility, and water infrastructure operators) came to a new understanding of how the watershed affected water flows and the effect of restoration and conservation. Thus, learning facilitated making connections between different belief systems. Bridging does not necessarily imply changes in belief systems, but rather recognition of relationships between them. The Council President and Technical Secretariat played key roles in actively meeting multiple epistemologies and worldviews, careful not to denigrate any and to provide evidence from studies, practice, tradition, and observation.

While few campesinos were involved in Working Group or Council meetings, the techniques selected aligned with their prior knowledge and epistemologies, which was critical as they would implement protected areas. Leadership was key for supporting their knowledge and perspectives, which the GRRN's office had learned through previous disaster resiliency projects. Additionally, while smaller in ambition than FORASAN, the Quiroz-Chira Water Fund provided a concrete local example where downstream farmers invested in upstream páramos protection.

Third, with the help of international development, the Council President and Technical Secretariat crafted an agreement Council members could agree to and would implement. They structured the agreement such that Council members could agree without committing their constituencies to action (which might have been challenging to secure). Thus, it was not solely knowledge dynamics, but the identification of ways stakeholder motivations aligned, accounting for material and socio-political motivations beyond water. For example, campesinos were keen on preventing future mining concessions and developing new economic opportunities and the GRRN was also responsible for biodiversity conservation.

Active support and incorporation of not just campesinos' knowledge, but their motivations and preferences, was integral to the quick implementation of new protected areas. Historic marginalization and exploitation of campesinos in Peru resulted in distrust of government intentions. While campesino communities had a seat on the Basin Council, they still faced substantial hurdles in participation: many lived far from the city where meetings were held, and had to leave daily responsibilities without funding for travel. Individuals varied in their Spanish fluency and ability to understand technical studies and models used in Council deliberations. Yet, in Piura, even when the campesinos were not present, their perspectives were respected and often incorporated, thanks to Council leadership.

While reaching agreement was in and of itself an outcome, whose preferences and interests it reflected show it was not a result of co-option or "acts of omission" that favored elite groups at the expense of vulnerable ones (Anguelovski et al., 2016). A seat at the table does not ensure stakeholders have equal influence. The city of Piura was the locus of decision-making and institutional power, tied with the surrounding agricultural areas that provided the region's economic base. While plausible that downstream actors co-opted decisions, we see that

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[12] Interview with GRRN given and translated from Spanish by author, March 8, 2017.

the Council reached agreement on a program that met the interests of upstream communities. This was particularly important for watershed protection over other water topics, as interventions would be carried out upstream.

While this paper examines knowledge dynamics, not all aspects of collaborative governance, it is nonetheless important to consider alternative explanations. Could stakeholders have reached a watershed protection agreement without the knowledge dynamics described? There are three main alternatives to consider, none of which fully explain the outcome without knowledge dynamics. First, disaster resiliency projects from the 2000s helped build the GRRN-campesino community relationship, but they were very small relative to the regional government's overall efforts and relationship with campesinos. Second, did stakeholders have sufficient interests to pursue watershed protection without Council agreement? Potentially, as the GRRN and campesinos had reasons for supporting the initial projects; however, it does not explain why water users dedicated funds to FORASAN. The Poechos Dam acts as a common pool resource and contributions did not translate into additional water rights. Finally, international development organizations were involved in several aspects (watershed modeling, pilot projects, etc.). Yet, while interviewees were appreciative, they emphasized local dynamics, none attributing the results to international development. Furthermore, while not part of this article, other places in Peru with similar assistance, such as Arequipa, did not reach agreement on watershed protection.

6. Conclusion

This case reveals several key points with regards to knowledge dynamics that cross the rural-urban interface. Knowledge and belief systems are distinct from, but intertwined with, motivations, which extend beyond the issue at hand and pure material interests. Here, alleviating poverty and resisting large-scale mining were key campesino motivations. Motivations extend further though, such as downstream water users' view that watershed protection was not their responsibility.

Knowledge and belief systems from urban and rural contexts often look different, meaning collaborative water management may face different knowledge dynamics than urban systems. In Piura, we see worldviews and epistemologies were different, but were bridged. Active incorporation of campesino knowledge and motivations was important, even when they were not very participatory or influential, which highlights that opportunity to participate is not sufficient. Not all actors' knowledge contributes to the same extent or is equally influential, but that does not deem them less valid or important. In Piura, leadership helped support and incorporate campesino perspectives.

A variety of methods contributed to the shift toward looking at water and land management above the dams. Modeling, workshops, and exchanges contributed to actors' agreement on watershed protection, using multiple methods to meet different epistemologies. The strategic identification of techniques also met multiple knowledge and belief systems, as well as motivations. It is difficult to disaggregate the two, as stakeholder actions involve a convoluted mix. Regardless, the initial focus on cloud forest and páramos ecosystems and flexible design that Council members could agree to without committing funds helped facilitate agreement.

As equity is a critical aspect of resiliency, it is important to look at whose ideas and preferences the agreement reflected. While there were downstream benefits, FORASAN also supported campesino interests. Bridging knowledge and belief systems contributed to agreement on ecosystem-based techniques, but it is important to highlight that consensus could also result from co-option. In Piura, it was mainly downstream, more dominant actors that gained a greater understanding of the upper basin's importance to water supplies and how it related to forest and wetland management practiced by campesinos. This shows why examination of knowledge and belief systems within collaborative governance is important, as it shapes whose preferences and vision gets

reflected in resulting decisions. Without explicitly looking at power relations and how they shape outcomes, disparities can be easily reproduced or exacerbated. This is often the case with respect to urban-rural relations, as cities are hubs for economic and political power.

Finally, knowledge validation, bridging, and use were not linear, but rather circular and iterative. Broad shifts in understanding the importance of ecosystems and the upper basin were underway simultaneously as discussions regarding the mechanism, financing, projects, and other water topics. Implementation of FORASAN was still nascent upon writing, so much remains to be seen in its implementation over time, and whose vision and preferences shape future decisions.

This case adds insights on knowledge systems for urban water management by examining the urban/rural relations. While urban systems are not homogeneous, the broader geographic context adds further variance. Insights from this case are specific to its context and situation; however, they show how examining knowledge dynamics beyond city boundaries is important for urban water governance. Further, knowledge use and contestation are couched in stakeholder worldviews and epistemologies, which provide additional insight when incorporated into the analysis. Future research with additional campesinos could help flesh out the diversity of their perspectives. Additionally, examining knowledge dynamics in other cases could dig deeper into the extent to which bridging knowledge systems was a determinant of collaborative outcomes.

Declarations of interest

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